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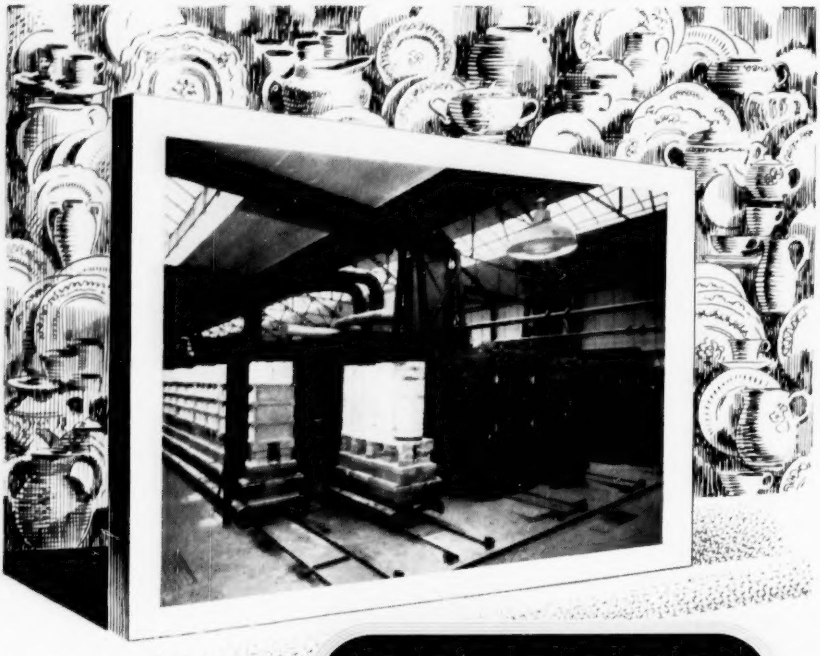

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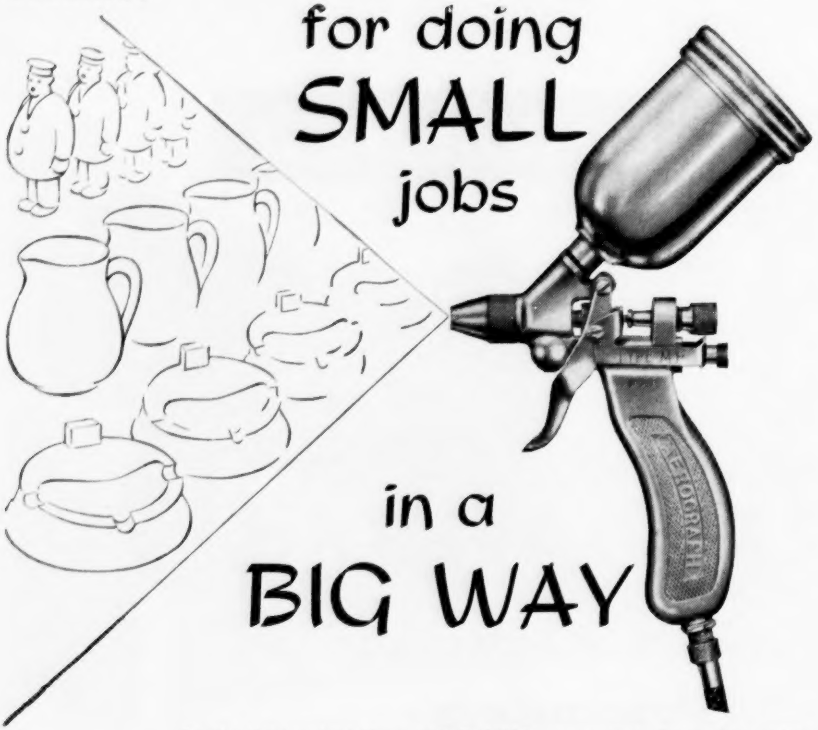

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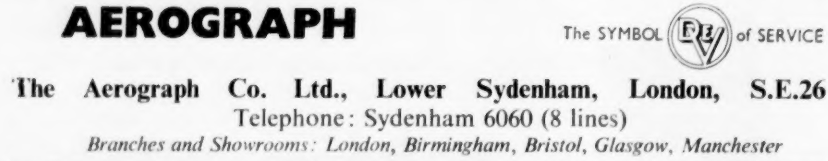

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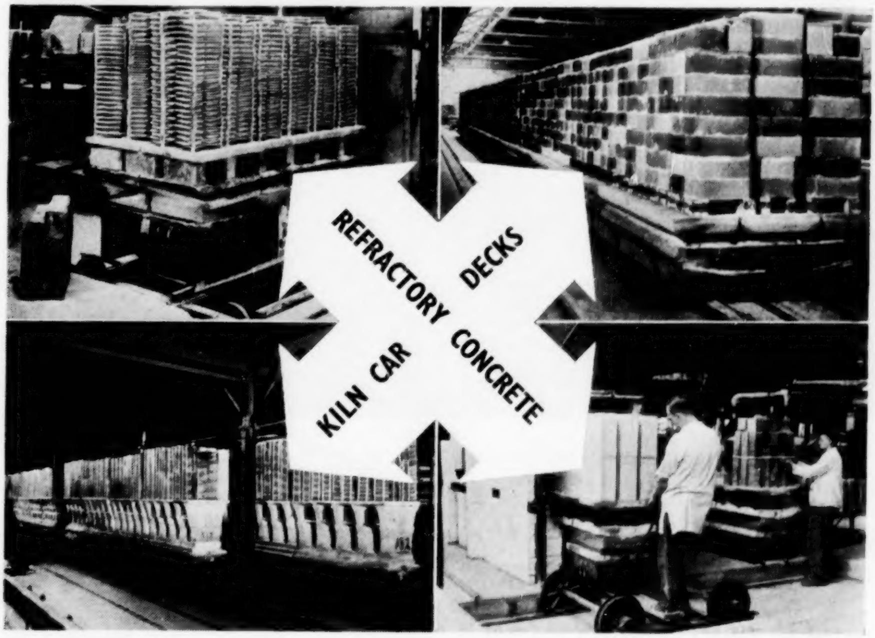

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CERAMICS

A monthly journal covering the pottery, glass, heavy clay, refractory and silicate industries.

NOVEMBER 1954

FEATURE ARTICLES

	Page
Editorial	395
Refractories for the Blast Furnace	396
The Drying of Tableware and Other Ceramic Goods by the Jet Drying Method. By W. Hancock	403
Tools for the Ceramic Industry—Hard Metal Tools	408
The Fourth International Ceramic Congress	413
Practical Hints on Slip-Making. By Kenneth Robinson	419

MISCELLANEOUS

The British Ceramic Society	402
Ceramics and Smoke Abatement	425
Classified Advertisements	432
Advertisers' Index	432

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Ceramics

VOL. VI — NOVEMBER, 1954 — NO. 69

Above All, Quality

RECENTLY Dr. Green, Director of the British Ceramic Research Association, gave a most stimulating and interesting talk to members of the Fuel Luncheon Club in London on the question of fuel usage and the ceramic industries.

He outlined to the members and their guests the problems facing the industry, and indicated quite clearly that the choice of fuel and fuel efficiency were not, in themselves, the end as far as the ceramic industry was concerned. Above all, through the gamut of building bricks, silica bricks, tiles, earthenware, bone china, electrical porcelain and so on, there were specific individual problems, and at the finish the two pre-eminently important factors were ultimate quality and ultimate output of the industry.

In other words, fuel saving in itself without maintenance of quality would, in the end, react unfavourably.

In an industry such as ceramics, dependent upon that material, clay, with its elusive properties, it is asking too much for the manufacturer to change his approach to firing without being absolutely certain that he was not going to suffer any financial or quality loss by increasing rejects.

This rather pinpoints the danger of the enthusiast—it is, of course, in the interests of the national economy that the choice of fuel and its efficient usage should be closely watched but there is often danger that these two aspects are viewed as ends in themselves. They are ends, of course, to the fuel technologist and the fuel efficiency engineer, but they are incidentals to the fuel user.

Those interested in sponsoring the cause of fuel efficiency must always bear in mind the problems of the customer and in whatever industry they apply themselves it must be with that background of information which allows them to present a case for fuel efficiency in a specific application which will not invalidate the quality of the ultimate article.

In this respect, the National Industrial Fuel Efficiency Service with its headquarters at 71 Grosvenor Street, London, W.1, is admirably suited, for it has enlisted among its staff those fuel engineers who have spent many years with the Fuel Efficiency Branch of the Ministry of Fuel and Power, and who between them know the industrial problems of so many industries at first hand.

Refractories for the Blast Furnace

(SPECIALLY CONTRIBUTED)

THE primary operation in the manufacture of steel is the production of iron from iron ore. The latter, consisting principally of the oxide, is reduced in a blast furnace by the action of carbon. For simplicity the reaction may be regarded as: —

$$Fe_2O_3 + 3\ C = 2\ Fe + 3\ CO$$

In order to make the operation continuous limestone is added to the charge so that it can combine with impurities in the iron ore, such as siliceous materials like clay and sand, to form a slag. At the temperature of operation this is run off from time to time and finds a variety of applications such as foamed slag for thermal insulators. Old slag heaps are now being rapidly converted to road material by mixing with tar.

Molten iron is also run off at intervals and thus the process becomes continuous, fresh material being added through the top of the furnace as required. The blast furnace gas is burnt in stoves, which, when hot enough, are used to heat the air-blast. This is injected into the charge to maintain the reaction producing the iron. The life of a blast furnace is conditioned by that of the refractory lining and continual efforts are being made to improve the quality of this. According to figures given by the British Iron and Steel Federation in 1947 there were 94 blast furnaces in operation. These produced 7,784,000 tons of pig iron and ferro alloys from 14,822,300 tons of iron ore and 8,567,000 tons of coke. The present figures are higher than this. It is interesting to note that the number of blast furnaces has declined from 683 in 1873 and 284 in 1920 to the present figure, whereas the production has increased. During that time there has been a very noticeable drop in the fuel requirements which have been about halved.

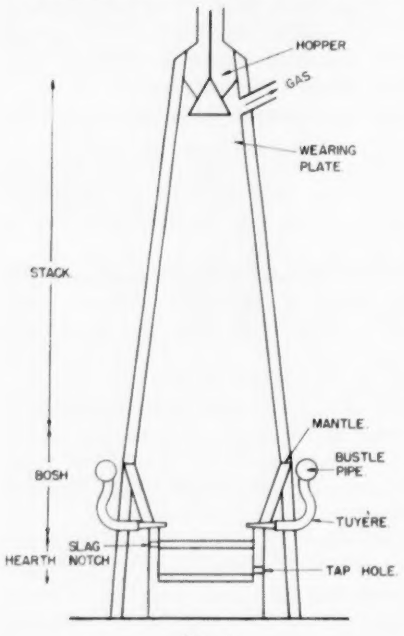

Fig. 1

Construction of the Blast Furnace

The various parts of a blast furnace are indicated diagrammatically in Fig. 1. They comprise hearth, bosh, stack, bustle pipe and down comers. The auxiliaries are the stoves and blast mains. The hearth is a cup built of refractory material which holds the molten metal with the slag above it. The diameter may be 20 to 30 ft. and the height 6 ft. or more. The side walls are 3 to 4 ft. thick and water cooled, and the hearth is built up to about 18 to 20 ft. thick to allow for erosion in service. The walls and bottom are made of large blocks and carbon is now tending to replace fireclay in these positions. Tap holes are located in this zone—that for the iron being about the level of the hearth bottom and the slag notch about the top of the

side walls. The bosh section is about 20 ft. high and tapers outwards from about 20 ft. diameter at the top of the hearth to 30 ft. diameter at the level of the mantle. The walls are about 3 ft. thick and cooled by the insertion of water-cooled bronze or copper plates. The tuyères, which are water-cooled and carry the hot air blast, are located at the bottom of the bosh. From the mantle the stack tapers inwards for a height of about 70 ft., the diameter at the top being around 20 ft. The brick lining varies from about 5 to 6 ft. thickness at the mantle to 3 to 4 ft. at the top of the stack. Here cast iron plates are inserted (wearing plates) to withstand the abrasion of the charge as it enters the furnace. The lower two thirds of the stack may be water-cooled.

The stack is sealed by a bell and cone hopper and the gases from the furnace are led off by a pipe at the throat through the down comers to the gas cleaning plant and thence to the stoves. The latter are connected to the bustle pipe which supplies air to the tuyères.

Stoves are important auxiliaries to every blast furnace, and there are often three to each one. In them the carbon monoxide which escapes from the top of the blast furnace is burnt, and the heat used to raise the temperature of a checker work of bricks. When these are sufficiently hot, cold air for the tuyères is drawn through the stove and becomes preheated. Meanwhile the carbon monoxide is switched to another stove which has been used previously, and is now too cold for further heating of the blast.

The life of the refractory material under the conditions of service determines how long the furnace will continue in operation before being blown out for reconstruction. An annual output of about 350,000 tons of pig iron from a furnace is now possible and an output of one to two million tons or more can be obtained before blowing out.

Wear on Refractories

The examination of a blown out furnace is very instructive as indicating which zones are subject to the most severe wear and also to gain clues of the causes of failure. An examination of the linings of three blown-out furnaces has been given in some detail by **W. Woodhouse, W. Hugill** and **A. T. Green** (*Iron and Steel Inst. Spec. Rep.* No. 26, 1939) and also by **W. R. McLain** (*Bull. Amer. Cer. Soc.* **19**, 62, 1940) and L. H. Van Vlain (*J. Amer. Cer. Soc.* **31**, 220, 1948). Fig. 2 gives some idea of the parts in which wear occurs according to these authors. It will be seen that the most severe wear occurs in the hearth, immediately above the bosh, and at the top of the stack. Refractories therefore will have to stand up to the following conditions in various parts of the furnace. The hearth will have to support the weight of molten metal at a temperature around 1,500° C. with, above it, a molten mass of slag. The refractories in the stack and bosh will have to withstand the effect of carbon monoxide, and the eroding action of hot dust-laden gas, mechanical abrasion from the charge, and the other possible effects of vapours of such things as zinc and the alkali metals.

Carbon Disintegration

The effect of carbon monoxide on firebrick may lead to the deposition of carbon particles in interstices, which can grow and cause disintegration. The deposition of carbon from the monoxide is catalysed by the presence of iron-oxide (Fe_2O_3) particles in the firebrick—$2CO = 2C + O_2$. It is stated

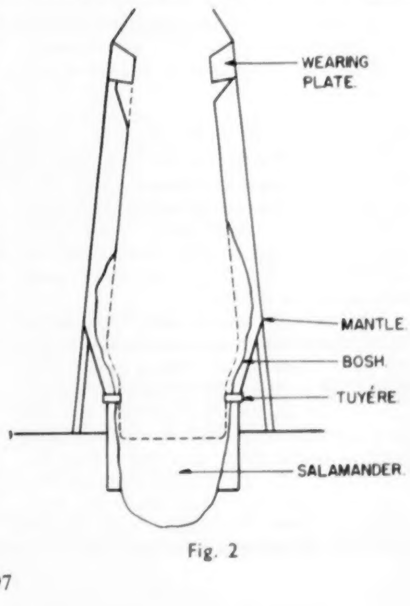

Fig. 2

that this proceeds most rapidly in the temperature range 400-500° C. (C. E. Nesbitt and M. L. Bell, *Iron. Trade Rev.*, **72**, 1603, 1923). It has also been claimed that only Fe_2O_3 is active in inducing the change, and that if it is converted to Fe_3O_4 or FeO or combined as silicate, disintegration can be prevented. Recently W. R. Davis and G. R. Rigby have stated that carbon deposition involves the reduction of iron compounds to iron.

The iron then adsorbs carbon monoxide followed by a reaction to give cementite Fe_3C. This may then either decompose to give carbon and iron or combine with further carbon monoxide to form iron percarbide. This may then decompose to give carbon and cementite:

$$6\,Fe + 2\,CO \rightarrow 2\,Fe_3C + CO_2 \rightarrow 6\,Fe + 2\,C + CO_2$$

$$20\,Fe_3C + 14\,CO \rightarrow 3\,Fe_{20}C_9 + 7\,CO_2 \rightarrow 20\,Fe_3C + 7\,CO_2 + 7C$$

(*Trans. Brit. Cer. Soc.*, **33,** 511, 1954.)

Construction of Hearth

Increased hearth diameters have imposed very severe conditions on the refractories of hearths. Penetration of metal through the joints may cause the refractories to float up to the metal surface. Escape of metal through the hearth constitutes a danger. It may be possible to close down temporarily to allow it to solidify but a break out can be very dangerous. This escape of metal into the hearth forms the salamander. McLain (*loc. cit.*) quotes a case where it had gone through a 9 ft. thick brick hearth into the concrete foundations of the furnace after a campaign in which more than a million and a half tons of pig iron had been produced. The salamander in this case weighed 500 tons. Cases are known of larger ones more than twice this weight, and their removal when the furnace is rebuilt may take up to six weeks.

To prevent salamander formation and the danger of molten metal breaking out, attempts are being made continuously to improve the hearth lining. The use of carbon refractories has led to a considerable improvement in preventing break outs, and increasing the campaign life of the blast furnace. Carbon in the form of a paste for ramming has been used since 1900 and is still used today, particularly in Germany. The preference in this country is for carbon blocks, which are corrugated and interlock in such a way that metal penetration is difficult, and the possibility of blocks floating up diminished. The manufacture of carbon ramming paste and carbon blocks has been described as far as German practice is concerned in *B.I.O.S. Final Report No. 819* (H.M.S.O., London).

Coke is the raw material used and is a hard foundry type with not more than 6 per cent. ash (10-20 mm. size). Ordinary coke oven tar with about 60 per cent. pitch is used as the bond, and it is important that its water content should be less than 0·5 per cent. The coke is thoroughly dried in a rotary dryer. It is then ground in a mill, steam-heated to about 80° C., to reduce its size to 7-9 mm., and then 16-18 per cent. of tar heated to the same temperature is added. After a thorough mixing (the time varies in different works from 4-20 mins.) the maximum grain size is about 6 mm. This paste is used for ramming and is stored in paper bags, being reheated before use. For the manufacture of bricks and blocks the coke is ground somewhat finer and 20 per cent. of tar added. Bricks are pressed in the usual way, but blocks are made in wooden moulds with the help of pneumatic hammers to ram the paste in. The firing is done under reducing conditions by packing the bricks and blocks in a mixture of equal parts of coke dust and quartz sand and then covering with a layer of the same mixture 20-30 mm. thick—a similar layer of sand goes on top of this. The firing cycle is as follows: Two days to heat to 1,000° C. (in a muffle kiln), 4 days soaking at 1,000° C., followed by slow cooling to room temperature over a period of 10-12 days. A case is quoted of a German furnace lined with carbon blocks up to the mantle which had made 3¼ million tons of iron with only two breakdowns at the tap hole in this time. Rammed carbon linings are liable to fail because of the development of cracks in them and in 1941 the Refractories Dept. of the United Steel Companies in this country began an investigation into the best methods of preparing carbon ramming compositions. This led subsequently to the manufacture of preformed carbon refractories of which the first were produced by Messrs. Thos. Marshall and Co. in

1942. Subsequently the company formed the Carbon Co. with the Morgan Crucible Co. to manufacture corrugated interlocking carbon blocks. These are laid in depth to form the hearth and the interlocking goes far to prevent them floating up. They are laid dry to avoid cracking of jointing cements except around the periphery where a ramming compound is used. The depth of carbon blocks suggested is 5 ft. Carbon possesses the very desirable properties of a refractoriness of over 3,000° C., and shows no deformation at 1,470° C. under a load of 2 tons/sq. in. Its mechanical strength is high and it is not wetted by molten metals or slags so that its resistance to attack is very high. The use of carbon refractories for the hearth and bosh now seems to be established, and at the Appleby-Frodingham works in this country it is reported that over 1,000 tons of carbon refractories have been supplied for use in the furnace bottoms, hearth walls and bosh of the "Seraphim" project. It is further stated that at this works 6 million tons of iron have been produced on carbon lined furnaces. Attempts have been made to construct furnaces with all carbon linings, i.e., to use carbon in the stack, relying on reducing conditions to prevent oxidation. The advantages of such a lining would be that the lining could be thinner, the life should be longer, and due to the thermal conductivity of carbon, cooling should be simplified.

Since carbon refractories are not wetted by molten material incidence of scaffolding is reduced. The preliminary results of all carbon furnaces were said to be promising. A Send (*Stahl u. Eisen, Dusseldorf*, **71**, 1361, 1951) has expressed doubt about the use of carbon linings for the stack of a blast furnace, and quotes the case of one in Finland which disintegrated in eight months. He suggests that this may be due to interaction with high concentrations of carbon dioxide at high temperature. E. W. Voice (*Iron, Coal Tr. Rev.* **164**, 1265, 1952) has suggested that, due to the high conductivity of carbon, some form of under-hearth cooling would prolong the life of the blocks, *B.I.S.R.A. Survey*, 1954, p.7, also deals with the same theme pointing out that if iron penetration occurs the relatively high conductivity of carbon ensures it remaining molten to a much greater depth with risk of floating up of blocks. It is suggested that under-hearth cooling could be done with air circulating in pipes inserted at any level between the bottom of the carbon lining and two feet below. Should there appear to be a danger of air leakage, which could damage the carbon, the pipes could be sealed with carbon paste injected under pressure. It is suggested that this would be a simpler method than cooling with water pipes as is done in an installation in Austria and another in Sweden. Cooling should enable the full benefits of carbon refractories to be realized in the hearth, as they are already in the water-cooled hearth walls and bosh.

Firebrick Refractories

For the other portions of the furnace and for stove linings various grades of firebrick are used. It should be noted, too, that high grade firebrick is still used in many places for hearth linings. The choice of the particular grade of firebrick is determined by the service conditions. Some or all of the following requirements will have to be met: (a) adequate refractoriness; (b) mechanical strength and high load bearing qualities; (c) volume stability; (d) low porosity; (e) low permeability; (f) resistance to slag attack; (g) resistance to abrasion; (h) resistance to the disintegrating action of carbon already referred to.

The conditions in different parts of the blast furnace and its accessories will determine the grade of firebrick required. Although carbon appears to be the best refractory, hearths are built in firebrick still and one has to visualize the building of a crucible which may be 20 or more feet in diameter and 6 ft. or so deep. The side walls may be 3 or 4 ft. thick and water cooled, while the bottom may be 20 ft. thick to allow for the erosion which will occur in operation. For such construction it is essential to have materials with adequate refractoriness under load. The temperature of the molten metal is in the region of 1,500° C. and the hearth will have to support the whole weight of the charge. Low porosity and permeability are required to prevent the molten metal penetrating the bricks. Volume stability is also essential to prevent cracks appearing in the

joints which would give the same trouble. It follows also that the joints should be as thin as possible, which means that the bricks or blocks should be accurate to size. For this purpose a 42 per cent. alumina firebrick is now used. Such a brick may have a percentage analysis SiO 53, Al_2O_3, 42, Fe_3O_3 1·7, CaO 0·3, MgO 0·3, Alkalis (Na_2O + K_2O) 1·0. The other properties of such a brick are true specific gravity 2.75, Bulk ditto 2.3, percentage porosity 14, pyrometric cone equivalent 33-34. (M.A.Fay *Brick Clay Rec.* 105 [3] 44 1944). Such bricks need to be well fired in manufacture, and the reheat test should show not more than 0.5 per cent. shrinkage after two hours at 1410° C. (J. H. Chester's *Steel Plant Refractories*, Sheffield, 1944). Where carbon hearths are built the latest practice in this country is to build the sub-hearth of 42 per cent, alumina firebricks.

The bosh is another area where the wear is heavy. The tuyères are located in the lower part of this zone. Carbon is now being used for this zone in some cases, but where the construction is in firebrick the same type as used for hearths is employed. The material must have the same refractoriness and resistance to slag attack, abrasion, and carbon disintegration. Near the tuyères the temperature may rise to over 1,600° C. and hence the need for water cooling. Bricks for the bosh zone need to be mechanically strong and to have low permeability and porosity. A low content of iron oxide which could catalyse the carbon deposition mentioned above is also important. A low permeability is important since slag attack is believed now to be due more to penetration of alkali vapours than to the action of molten slag (M. A. Fay *loc. cit.*). Needless to say the brick must be stable as regards shrinkage on heating as for hearth refractories. A 42 per cent. alumina firebrick is widely used in this zone.

In the stack it is possible to use two types of refractory. At the lower portions above mantle the temperature may be in the region of 1,400° C. The requirements for the lower portions of the stack (approximately two thirds of the height) are similar to those in the bosh and similar bricks are used. Water-cooled copper plates are usually inserted as for the bosh where temperatures make this necessary. The upper one third of the stack needs a brick which will stand severe mechanical abrasion and which will resist carbon deposition. The refractoriness can be less since temperatures in this zone are usually less than 500° C. A 36 per cent. alumina firebrick is used and cast iron wearing plates are usually placed in the furnace throat to give added protection against abrasion from the charges dropping in from the hopper. These are often backed with refractory concrete made from cement fondu and firebrick grog (36 per cent. alumina).

Stove and Pipe Linings

The accessories such as pipes and stoves also need fireclay refractories for linings. The bustle pipe which carries large volumes of hot air from the stoves for the tuyères is lined with firebrick for insulation. The pressure is high, and the brick required must have a low porosity and permeability. Since the temperature is from about 480° C. to about 800° C. high refractoriness is not essential and a 30 per cent. alumina brick is used. Dust catchers and gas mains operate at lower temperatures in the region of under 300° C. and so a low heat-duty brick is suitable. It must protect the mains against abrasive dust carried out of the furnace. Such a brick might be of the 30 per cent. alumina type having a P.C.E. value of 28, and porosity 18 per cent.

Stove refractories must be able to bear load and have a low after-contraction. This is to prevent collapse of the checkers and to render the lining gas tight at high temperatures. It is convenient to divide stove linings into three parts, walls, dome and checkers. The walls may be 80 feet high and thus the load on the lower courses is considerable. Combustion of furnace gases may give a temperature in the region of 1,400° C. at the top. The bricks must withstand this. At the same time there must be no appreciable shrinkage to open up escape routes for the gas which might then short circuit the checkers. The highest temperatures tend to be reached in the tops of the stoves. In a modern construction in this country the walls of the stove

(*Continued on page 402.*)

THE BRITISH CERAMIC SOCIETY

WE give below abstracts of the three papers appearing in the Transactions of the British Ceramic Society for September, 1954.

The System TiO_2-SiO_2, by R. C. DeVries, Rustum Roy, and E. F. Osborn.—A reinvestigation of the system TiO_2-SiO_2 has resulted in an interpretation that differs in certain respects from previously published diagrams. Two liquids co-exist at temperatures above 1,780° ± 10° C. over the range 19 to 93 per cent. TiO_2 Bunting's eutectic composition (10·5 per cent. TiO_2) has been confirmed. Phase relationships and optical measurements indicate that the extent of solid solution in this system is negligible. Molar refractivity data suggest that Ti^{4+} has a co-ordination of less than 6 in the glasses formed in this system.

Contributions to the Study of Efflorescence, Part VIII. The Camerman Theory, by B .Butterworth.—A theory, proposed by C. Camerman of Brussels, that efflorescence on brickwork is usually due to salts formed by a chemical reaction between cements and bricks, rather than to salts originally present in either material, is critically examined. Experiments are described which repeat some of those made by Camerman with greater attention to significant detail, and an essay in interpretation of the facts in terms of the more usually accepted concepts is offered. It is concluded (1) that Camerman omitted vital blank experiments and was unwise to rely on a test made with porous pots of fired clay to prove that his cements did not effloresce *by themselves;* (2) that he has incorrectly interpreted some of the relevant published work and has apparently not had access to some important papers; (3) that he has not given convincing reasons for rejecting certain pieces of evidence that do not fit into the theoretical picture he has constructed; and (4) that the facts can be explained without recourse to his theory. Camerman's work has, nevertheless, performed a useful service by directing attention to the importance of soluble salts from the mortar in causing efflorescence on brickwork, a hitherto neglected factor.

The Effect of Insulation on Working Conditions in a Hoffman Kiln, by M. E. C. Stedham.—Methods of measuring the comfort or discomfort of working conditions in a continuous kiln are discussed, and the one found to give the best correlation with the opinions of the workmen is described. The effect of insulation in the kiln walls is investigated, and is found to increase the temperature and make working conditions more arduous.

(*Continued from page* 401.)

were constructed mainly in 36 per cent. Al_2O_3 brick with a top portion of 42 per cent. alumina bricks which also give greater resistance to thermal shock. The dome of the stove, which also has to stand higher temperatures than the lower parts has been made in a recent construction of 50 per cent. alumina bricks bonded with 50 per cent. alumina fireclay. The checkers are also made of fireclay.

The highest temperature is at the top where the load is lightest. The thermal shock is also greatest here. Temperatures in the checkers may range from about 1400° C. at the top to 200-300° C. at the bottom. The requirements for checker bricks are low expansion to prevent movement in the alternations of temperature to which they are subjected, good load bearing capacity, while in the top good refractoriness and resistance to thermal shock are desirable. Dense bricks have higher heat capacities than more porous ones. For checkers 42 per cent. alumina bricks have been specified recently in a large construction for the top and 36 per cent. alumina bricks for the bottom.

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The Drying of Tableware and Other Ceramic Goods

By the Jet Drying Method

by W. HANCOCK, M.I.B.R.E., A.M.I.E.E.

6.—JET DRYING AND THE WALL TILE INDUSTRY

IN this important branch of ceramic manufacture, drying methods differ from those used for plastic tableware in one main respect. Tiles are generally formed by the dust-pressing method, and such dust is usually prepared by disintegrating partially-dried body press-cakes, and is normally in the correct condition for dust pressing when its moisture content is about 10 per cent., calculated on a dry-clay basis.

The filter-press cake, from which such tile dust is prepared, contains approximately 30 per cent. by weight of water on a dry-clay basis. This implies that each ton of dry tile-body is associated with 6 cwt. of water in the press cakes as removed from the filter press. Of this 6 cwt. of water, 4 cwt. must be removed to obtain partly-dried body in a suitable condition for disintegrating and dust pressing. This leaves some 2 cwt. of water to be removed from each 22 cwt. of dust-pressed tiles after they leave the machine: i.e. during final drying and in the early stages of firing.

Distribution of Moisture in Press Dust

Experience and research leave no doubt that even distribution of moisture in the tile as pressed is a prerequisite of low-loss production.

By comparison with plastic-made tableware, the mechanical strength of tiles as they come from the press is low, and lack of correct distribution of moisture in the tile dust will result in irregular distribution of hardness in the dust-pressed article. As a consequence, the pressed tile will be liable to local stresses, which may well induce cracking during the subequent drying and firing operations.

One of the essentials of wall-tile manufacture, then, is that the semi-dry dust before pressing must possess as uniform a moisture content as possible.

Drying Press Cakes to a Controlled Moisture Content and Distribution

Many methods for the bulk production of tile dust are in operation, or have been tried out. For example, in a recent comprehensive report to the Institute of Fuel, L. Bullen describes no fewer than twelve different methods. Most of these are slow, and are apt to produce a badly distributed moisture-content in the dried dust, which defect can be the cause of high loss during subsequent manufacturing operations.

In one method—the strip dryer—drying was rapid (6 mins.) and was conducive to uniform moisture distribution, but it suffered from the defects of high installation and of high fuel-cost; and, also, from high labour-cost per ton of dust produced. The high fuel-cost was due to a town-gas price of over 9d. per therm, coupled with a low, overall thermal-efficiency of 26 per cent.

However, the making properties of the dust were described as being definitely better than of that dried in a tunnel dryer. Over a period of one day, tests made every ten minutes showed only 0·4 per cent. moisture variation.

The reasoning which led to the development of the jet-drying technique in the tableware industry has led to identical conclusions regarding the drying of press cakes. In brief, traditional

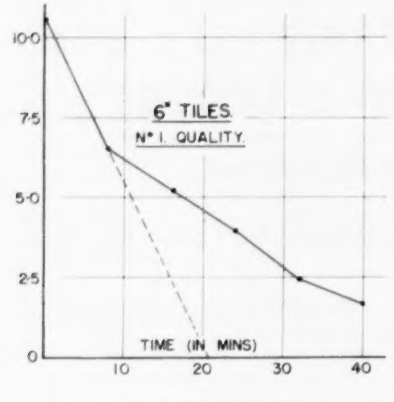


Fig. 12

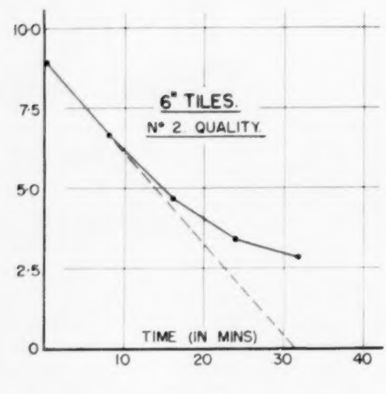


Fig. 13

bulk-drying methods tend inevitably to yield a poor distribution of moisture in the partly-dried press cakes, and this is coupled with unnecessarily low thermal-efficiencies, and high fuel-costs.

New Method for Drying Tile Body Press Cakes

The new method for drying body press-cakes to a uniform and controlled moisture-content is based on experience gained in the use of the high-velocity hot-air jet principle as applied to the drying of plastic-made tableware.

As already described the advantages of this method of drying are:

(a) Low capital outlay.
(b) Low fuel costs as a consequence of high thermal efficiency and rapid, uniform drying.
(c) Low labour costs.

Experience in the tableware field proved that rapid drying does not result in increased losses due to cracking. In fact, because of the uniformity of the drying, losses are reduced during both drying and firing. In general, the thinner the article being dried, the greater becomes the maximum safe rate of drying. The only practical restriction on drying rate is the risk of cracking.

In the drying of body press-cakes, the risk of cracking is no longer a restriction on drying speed, and thin sheets of press cake can be dried at very high speeds using jet drying *with the assurance of an even distribution of moisture content throughout the product.*

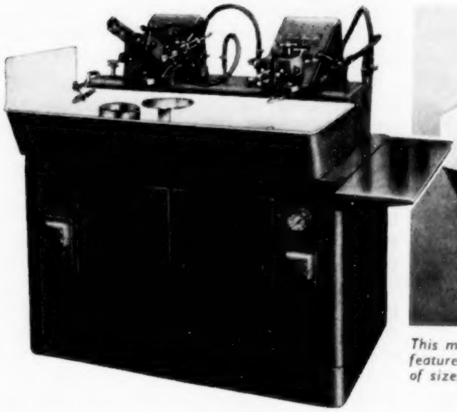
The jet drying method combines both thermal and labour efficiency, and so reduces the cost of the articles being made.

The new method makes use of the following processes:

(a) Rolling out the press cakes to reasonably thin sheets before drying.
(b) Drying the rolled-out sheets of plastic body by use of high-velocity air jets applied to both sides simultaneously.

The press cakes, which are normally 2 ft. 9 in. square and $1\frac{1}{4}$ in. thick, are first cut into two rectangles 2 ft. 9 in. width by $1\frac{1}{4}$ in. thick. Thus, before rolling, each piece of half press-cake size has an area of approximately 4 sq. ft. By passing the press-cake through closely-set rollers, the thickness of the cake is greatly reduced, thus giving an increase in area to be exposed to the drying agency.

In the pilot plant the rollers were 3 ft. long with a clearance between rollers of $\frac{3}{8}$ in. Therefore each half press-cake as it passes through the rollers is reduced in thickness from $1\frac{1}{4}$ in. to $\frac{3}{8}$ in., and since this thickness is approximately 3/10 of its original value, with the clay volume remaining unchanged, the surface area of the cakes is increased by $3\frac{1}{4}$: i.e. from 4 sq. ft. to approximately 13 sq. ft.



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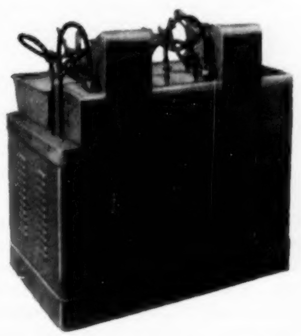
★ Moving parts isolated from operator's hands. ★ Power disengagement before profile leaves article, eliminating final vibration. ★ Twin drive and twin brakes to each spindle. Drive belts replaceable without dismantling spindles. ★ Air, water and electricity supply connections at one point. ★ Instantaneously variable air pressure. ★ Turret head and Scrapper Arms available with three tools ★ Grease gun lubrication One shot system available. ★ Immense rigidity, smooth running and high standards of precision. ★ Finished in green and cream enamel with bright parts chromed, providing incentive to operator for clean maintenance.



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WB.7.

The weight of the original press cake is approximately 95 lb. plastic, and consists of:

73 lb. dry clay
22 lb. water

Therefore, the half press-cake contains 36½ lb. dry clay and 11 lb. of water, and this when rolled out has a total surface area (both faces) of 26 sq. ft. In other words, from each rolled out press-cake containing 36½ lb. dry clay and 11 lb. water, 7¼ lb. of water has to be evaporated, to leave behind about 40 lb. of damp dust containing 3¾ lb. of water and 36½ lb. dry clay.

Pilot Plant Details

The pilot dryer was designed to lead to the production of 70 tons of press dust per day, and this quantity of clay was to be produced from filter presses with an individual capacity of 3 tons per pressing cycle. The drying unit is almost identical in construction with the dippers dryer for glazed biscuit previously described, and which has proved successful under varied factory conditions.

The necessary plants consists of:

(a) The rollers 3 ft. long.
(b) The jet drying unit.
(c) Disintegrator and dust storage.

The jet drying-unit has an overall length of 7 yd., and of this the jet panels occupy a length of 14 ft. The actual conveyor belt of open-mesh construction, which allows the high velocity hot-air jets to play on both upper and lower surfaces of the clay sheet.

The working width of the dryer is 4ft., and the sheets of clay in the dryer proper are 26 sq. ft. in area (both faces). The belt speed is 1 ft. per min., which yields a throughput of 820 lb. per hour, or 9 tons (3 presses) per day of 24 hours.

Dryer Designed to Yield a Required Output Per Day

Suppose the required output to be 70 tons per day. The pilot unit with an overall jet length of 14 ft. and a conveyor speed of 1 ft. per min., as described, will dry 9 tons of press cake in one day.

The output of the jet drying plant is flexible as regards:

(a) The basic drying time.
(b) The length of the jet panels and the conveyor speed.
(c) The width of the jet panels.
(d) The number of conveyor lines.

To deal with 70 tons per day, 8 units similar to the pilot plant would be required.

If, however, the length of the panels is increased to 28 ft., the conveyor speed can be doubled, and the output becomes 18 tons per day. If, as in the dippers drying unit, two belts (one above the other) are used, the output becomes 36 tons per day, or 72 tons per day from two units, fed by one operative per shift.

Any increase in the width of the panels will give a proportionate increase in output, and a similar statement is true as regards increase of dry-bulb temperature and air velocity above 140° F. and 1,500 ft. per minute respectively. The unit, therefore, possesses extreme flexibility as regards output in all respects.

Jet Drying of Pressed Wall Tiles

Assume that a semi-automatic tile press will produce about 350 dozen 4 in. tiles per day (8 hour) in approximately 7 hours' actual pressing time; and that a fully-automatic machine will yield an output of between 4 to 6 times the above quantity

Consider an output of 1,400 doz. 4 in. tiles per 8 hour day overall. The "total surface" of both sides is double the area covered by the tiles. The "total surface" of this quantity of tiles is approximately 4,000 sq. ft. This is the surface through which evaporation of the 10 per cent. moisture must proceed, and is equivalent to 2,000 sq. ft. of tiles.

Experiments with the jet drying of tiles, quoted below, shows moisture content can be reduced to about 2 per cent. in 30/40 minutes with jet velocity of 1,500 ft. per minute, and a dry bulb temperature of about 140° F.

A jet dryer approximately 4 ft. wide will take on the mesh conveyor belt one dozen 4 in. tiles in each row, so that a panel length of up to 24 ft. will carry 72 dozen tiles, or at 6 ft. wide 108 dozen or say 100 dozen. If 100 dozen tiles are dried in ½ hour, production per 8 hours would be 1,600 dozen per day through a jet dryer with a panel length of 24 ft.

It is thus seen that in its simplest form, with one conveyor belt only, an horizontal jet dryer of reasonable

length will deal with a machine output of 1,400 dozen 4 in. tiles per day. With a double conveyor system as used in the dippers dryers, for flat, dipped ware as previously described, the output from the unit would be 2,800 dozen per day, with proportionate increases at higher dry-bulb temperatures above 140° F., or with higher air-velocities at the jets.

Jet Drying Tests on Pressed Wall Tiles

A number of pilot plant tests on the jet drying of 4 in. and 6 in. wall tiles have been carried out, in which tiles have been rapidly dried by high-velocity (1,500 ft./min.) jets in 30 to 40 minutes down to moisture contents of between 1 and 2 per cent. Results on two different tile bodies are shown in the two graphs, 6 in. tiles being used in the tests. The continuous lines show the actual experimental figures obtained from 6 in. square tiles $\frac{3}{8}$ in. thick, each weighing approximately 16 oz. damp as pressed, and $14\frac{1}{2}$ oz. dry.

With No. 1 quality of tiles, the water content of each tile was $1\frac{1}{2}$ oz. Three-quarters of this was removed in approximately 30 minutes, leaving tiles at $2\frac{1}{2}$ per cent. moisture content, or between 1 and 2 per cent. moisture after 40 minutes. The dotted lines show the high rate of evaporation during the early stages of jet drying, between half and one-third of the moisture being evaporated during the first ten minutes. The average drying rates are of the order of 2 oz. water per sq. ft. of total tile surface per $\frac{1}{2}$ hour, i.e. 4 oz. loss per hour per sq. ft. of total surface. In comparing drying rates already experienced in works with jet dryers on plastic flatware, there is every reason to conclude that much quicker drying could be obtained with safety at higher dry-bulb temperatures, and still higher velocities at the air jets.

Absence of Water Gradients across the Drying Tiles.

Because of uniform distribution of the high-pressure jets over the drying surfaces, there is no evidence available that water gradients exist between centre and outer edges of tiles dried by this method.

When tiles are dried in bats or bungs (as the work of L. Bullen has already shown) the more rapid the drying, the steeper the water gradients become. These gradients produce internal strain, and in bodies of relatively low strength in the green state such strains can cause incipient cracking.

By reducing the variation of moisture content in tile dust to a minimum by jet drying the press cakes, and following this by the jet drying of pressed tiles prepared from such dust, much can be done to keep losses due to cracking during drying and firing to a minimum.

GLENBOIG UNION FIRECLAY COMPANY

The refractories industry was represented at the Scottish Industries Exhibition by the Glenboig Union Fireclay Co. Ltd., now 130 years old, but progressive and comprehensive in its range of activities. The firm covered two main interests: the production of refractories, and the marketing of specialised sands. The refractories shown included their latest Dykehead brand. This brick, designed to withstand abrasion and strong acids, has a particular application in water washed ash hoppers, where it has been used with considerable success.

The firm also showed a range of twelve sands from their Levenseat Quarry, ranging from the coarser horticultural types to the finer sands which have been used extensively in recent months in the shell moulding process. Their texture and cohesion make for a very satisfactory mould, virtually eliminating machining and giving a precision finish which promises a considerable future for the process.

The glass island.—There is growing Japanese interest in buying large quantities of silica sand from Pulau Tekong Kechil, the "glass island" off Changi, Singapore. The sand on this 200-acre island contains 99·7 per cent. silica, and is unique in South-east Asia. Lenses, cut glass and fine glassware are made from this sand, a vast supply of which exists.

"Biggest obstacle to disposing of the sand so far has been high freight charges," said Mr. G. H. Kiat, a Singapore businessman, speaking on behalf of the island's owner, Mr. Philip Hoalim.

TOOLS FOR THE POTTERY INDUSTRY

Hard Metal Tools

(SPECIALLY CONTRIBUTED)

IN these post war years all industries have been urged to produce more for export at a relatively lower cost to enable the mass of the population to survive on an island that cannot on its own support them. In this drive for greater effort and more production, plant modernisation has not been overlooked and in this latter respect, the pottery industry had led the field. As with the engineering industry, new materials have been found and generally utilised, thus the pottery industry has found the advantages to be gained by the use of hard metal tools.

Process of Manufacture

To assist in applying these tools to our own industry, it is as well if we understand that hard metal is manufactured by the process of powder metallurgy. Owing to its method of production, the resultant material is not homogeneous, as is steel, but consists of hard carbides held together in a matrix of cobalt. As the material differs from steel, so does its method of use and application and also its degrees of hardness. The main advantage in using hard metal is its greater hardness compared to that of steel for, whereas a high-speed steel tool bit has a hardness of 84 Rockwell A scale and a hardened gauge 80 Rockwell A scale, hard metal has a Rockwell A figure of 92, which is a considerable increase in hardness over steel.

With this greater hardness, however, it is essential that extra care must be taken in its use as increased hardness begets at the same time greater brittleness. It is also important to remember that hard metal as supplied to the user is already hard, and it can neither be hardened, softened nor tempered by the application of heat.

It is always wise at the outset to have hard metal tools made and serviced by a reputable maker and it is also in numerous cases more economical from the cost point of view, there being an art in grinding and polishing the hard metal. Unless the correct grinding wheels are used and, during use, kept in good condition, troubles can arise from cracked hard metal tips or inserts.

On tools such as handlers, knives, hand turning tools and sorters or on some of the special cup form tools where the operation of brazing the tip to a steel shank is required, great skill in brazing is called for and unless quantities of these tools are to be made, definite savings can be achieved by purchasing tools from the manufacturer.

In the case of the large user of pottery tools, it pays dividends, as has already been proved by a number of firms situated in the Potteries, to install the necessary plant for making and servicing their own tools, only buying the necessary tips from the manufacturer, who will be prepared to supply the hard metal ready formed to the requisite size and shape, including the various clearance angles required.

Factors Governing Design

In applying this new material, certain factors will govern the ultimate design of the tools, factors which cannot be varied and which will spell success or failure to the whole project.

The following salient points should therefore be kept in mind:

a. Hard metal as supplied cannot be softened by heating to enable further easy working.

The information contained in this article has been supplied by Protolite Ltd., whose valuable assistance we wish to acknowledge.

b. The section of the hard metal must be of sufficient cross sectional area to avoid breaking or cracking either during the manufacturing process or during clamping or brazing to a suitable tool holder.
c. All hard metal must be supported by a holder or backing plate to avoid putting direct strains on the hard metal.
d. Size and shape of the hard metal parts can be governed by the process of manufacture. It is therefore wise where large sizes are required to consult the manufacturer before proceeding to design large tools, or tools where intricate shapes are involved.

Tools Available

With these points in mind, it will be worth while to review the range of tools in use where hard metal can be applied with distinct advantage.

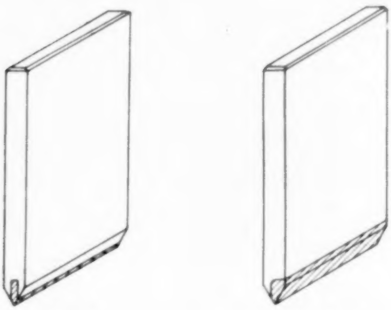


Fig. 1 Fig. 2.

The simplest tool will no doubt be the hand sorting or chipping tool (Fig. 1), and it is here advisable to depart from the usual hard grade of hard metal to a tougher grade such as is used for woodworking tools. There are two methods in popular favour for making these tools, one being the type where the hard metal tip is brazed into a slot in the body of the tool, the other being where the hard metal is lapped onto the side of the tool, the blow being taken by a step in the shank (Fig. 2).

Next in order of popularity is the hand turning tool for the production of cups. This range includes the footing and similar tools and although skill

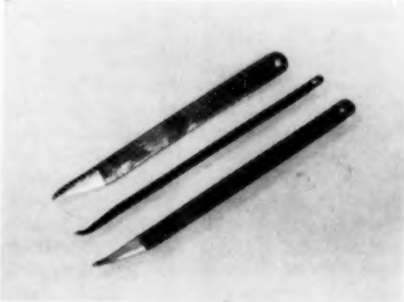


Fig. 3

is required in both attaching the hard metal to the tool shanks and subsequently grinding the tools, it is not beyond the skill of the good class mechanic found throughout the Potteries to produce satisfactory tools of this type.

The latest addition to the range of hand tools is the one of handlers knives. Until recently it was understood that hard metal in very thin sections and of suitable shape could not be obtained. We have however seen examples of well made tools having hard metal ends bent to the correct size and shape (Fig. 3).

The familiar potter's "jolly" can quite well accommodate tools faced with hard metal and foremost amongst these will be the spreader tool. These tools can be made in a variety of ways, the most popular being as illustrated in Fig. 5. Certain users, however, like to have a complete facing of hard metal brazed to the shank (shown in Fig. 4), which is, of course, more ex-

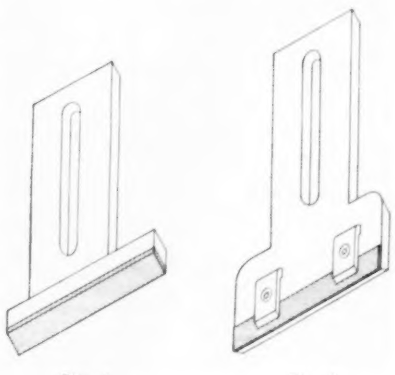


Fig. 4 Fig. 5

pensive initially than the previous method illustrated.

The form tool for the production of flats or plates, dishes and saucers, calls for a high degree of skill in grinding and polishing as it must follow accurately the finished form required, also owing to the brittleness of hard metal, great care must be taken to avoid cracking it by undue pressure and isolated heat. We have seen some instances of these tools where the hard metal has been brazed on to the face of the tool holder, but this method is not to be recommended as the softer steel tool holder wears away behind the hard metal face causing marks or "slurries" to appear on the finished product. With the clamped-on type of tool (Fig. 6), however, as this wear occurs, the hard metal can be moved back to overcome this difficulty. These remarks apply of course equally well to the internal cup forming tool, the major differences being in form and of course in clearance angles, the latter being greater to allow for clearing the internal diameter of the cup or bowl.

A further tool which is becoming increasingly popular is the side tool for the automatic cup turning machine, also the scraper tool used on the same machine. These tools, however, are not usually made by clamping

Fig. 6

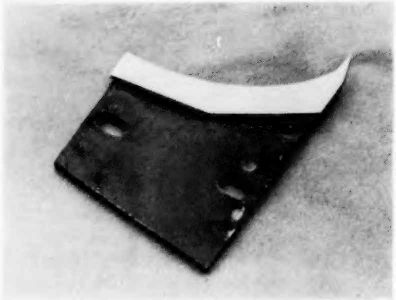


Fig. 7

the hard metal to a tool holder, the joint being made by butt or lap brazing. This is not one of the easiest operations, as the length to be brazed does not lend itself easily to torch brazing (Fig. 7).

Other uses for hard metal can be found in the Potteries such as the scraper blade used on the various gold band edging machines and hand fluting tools, these however are only modifications of tools already described in the previous paragraphs.

To depart entirely from this type of tool, many users who have adopted glazing by spraying instead of dipping, are now using hard metal nozzles and needles for the spray guns and finding that besides giving increased life, they are saving in the quantity of glaze used and producing a better finished, more uniformly glazed article.

Advice to New Users

The foregoing resumé of the field of application of hard metal tools to the pottery industry will, it is hoped, enable a new or prospective user to estimate the number of tools which his works may require and will ultimately require to service. After this estimate has been arrived at, two courses lie ahead, one being to rely on the services of the specialist toolmaker to supply and service all the tools required, the alternative being to institute one's own toolroom or tool section. The major initial cost and upkeep cost in a project such as this will be the diamond wheels required in the grinding operation. The plant of course will be capital expenditure and in most cases will not require replacement for a number of years.

The quantity of plant required will depend on the number of tools to be produced and serviced, but basically the equipment purchased would have to include brazing plant in the form of, for simple tools, torches and vice, also a small hearth, but for the larger more intricate tools it would no doubt pay dividends to install a small brazing muffle.

Three brazing mediums are normally employed in the engineering industry for joining the hard metal tip to the softer metal shank: copper which melts at 1080°C., bronze at 860°C. and silver solder at 650°C. It is this latter material with which we shall be concerned in the pottery industry, although in some instances solder and plastic cement have been used with excellent results.

Brazing

Extreme care must be used during any brazing operation and utmost cleanliness should be observed to ensure freedom from troubles such as tips cracking. The surface of the tip to be brazed should be cleaned by lightly grinding over the area of contact with the shank and if after grinding any grease has been deposited even by touching with the fingers, the tip should be further cleaned by immersion in carbon tetrachloride or a similar cleaning medium. One further point to observe is that the hard metal tip should not be subject to localized heating as this is fatal to the tip, therefore in torch brazing the flame should not at first impinge directly on to the tip and should at all times be kept moving over the entire surface of shank and tip to obtain even heating and expansion.

When the brazing material has melted, the tip should be lightly pressed on to the shank and immediately plunged into a bath of powdered electrode carbon to gradually cool off.

Grinding

The next operation will be to grind the tip to its final form and for this, the major and most costly part of the plant will be required. Besides grinding wheels for grinding the steel shanks or holders, special wheels will be required for the hard metal tip, these wheels being obtainable from all the recognised grinding wheel manufacturers.

The actual machines required will, as stated before, be governed by the number, shape and size of tool to be produced and serviced, but the minimum requirement will be a good double-ended motor-driven bench or pedestal grinder and in a number of instances a surface grinder will be of distinct advantage.

To commence the production of tools, the following grinding wheels should be obtained:

Operation	*Type of Wheel*	*Grit*
For grinding steel shank or tool holder	Aluminium Oxide	60
For rough grinding hard metal tip	Silicon Carbide	60
For grinding prior to diamond lapping.	Silicon Carbide	100
For diamond lapping	Diamond	220

The above wheels should all be run at a speed of approximately 4,500 to 6,500 surface feet per minute, the diamond wheels running at the higher speed.

It is also necessary to equip your tool maker with several small diamond impregnated hand laps of 120 to 200

Fig. 8

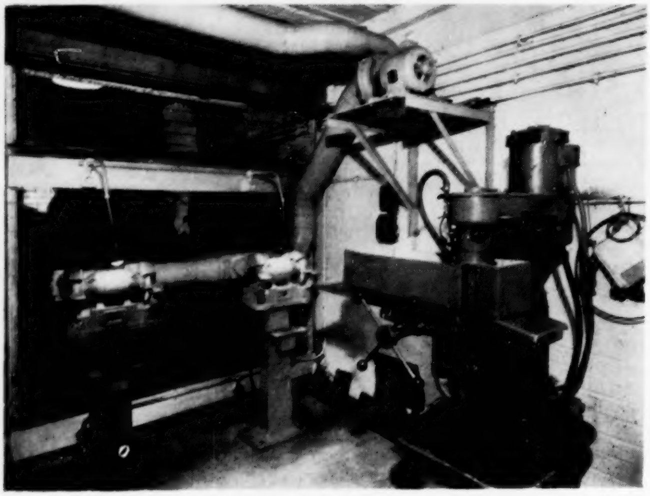


Fig. 9

grit and various shapes such as rounds, triangular and square or rectangular, these to be used for final finishing of the various forms.

Other equipment required will consist of the normal engineer's tools such as vice, bench or pillar drill, files, drills, etc., all as found in the normal maintenance engineer's workshop.

Value of Machining Equipment

With this equipment installed and suitable personnel to operate it, the manufacture of hard metal tools can prove of benefit to all the larger potteries and no doubt the smaller firms can by the use of such tools reduce costs and increase production, thus benefiting both the company and the employee.

In Figs. 8 and 9, we show a plant such as has been described, in successful operation in the Potteries and it is interesting to note that this plant was installed over four years ago and has in this time proved itself economically sound and of great assistance to the company concerned.

The Fourth International Ceramic Congress

ITALY—1954

(SPECIALLY CONTRIBUTED)

ITALY is inevitably associated with the origins of modern history and art, dating from the Roman era and the early Christian epoch. In matters artistic; whether architectural, or the art of the sculptor, painter and craftsman of the past, Italy is one of the starting points of the race which we call "Modern Civilisation."

To stand on the first of the Hills of Rome, beside the remains of the first of the milestones of the Roman Empire, with the ruins of the first commercial bank below, and the Coliseum and the Appian way not far distant, calls to mind the saying that "all roads lead to Rome."

But one had not really realised that Italy might be in the forefront of ceramic production by the most modern techniques known to ceramic science.

That is to say, not until the opportunity had arisen to look over some of the largest and smallest of the Italian ceramic factories, as we were privileged to do during the Fourth International Ceramic Congress, held in Italy, and covering the period — 27th September to 2nd October, 1954.

However, the object of this report is not necessarily to eulogise, but to describe and report, so that those who have not yet, perhaps, had the opportunity of seeing our Italian counterparts in ceramic action, may at least read some measure of factual recording of what is happening, and what was seen or heard there in the ceramic field. They may then stand warned against premature complacency regarding our own achievements, and come to realise that one of the historical birthplaces of ceramic art and science is today in the vanguard of production methods, and might well point the way to future developments in Britain.

The Present-day Italian Whiteware Industry

In the respects of factory planning, engineering practice, kiln design and quality of production, many of the Italian whiteware factories merit full marks.

We use the term "whiteware" to differentiate the table ware and sanitary ware industries, from the heavy clays, refractories, electrical porcelain and chemical stoneware branches of ceramic manufacture.

The Fourth Congress catered for six groups: (1) Heavy clays. (2) Refractories. (3) China (porcelain) and artware. (4) Earthenware. (5) Sanitary ware of all types including fireclay, and chemical stoneware and electrical porcelain. (6) Wall tiles.

These groups met in different production centres during the first two days of the Congress but centred on Florence for the rest of the week.

What is said in this article may not necessarily apply to all these branches of ceramics, but is focused mainly on the production issues of groups 3, 4, 5 and 6. In Britain, in the past, mechanisation seemed to come first in the heavy clays industries, and to spread later to the whiteware branches. In Italy, as perhaps in this country, what today exemplifies the best on the mechanical, technical and artistic sides of the tableware industries might well, in the future, reverse history and apply to the heavy clay branches of ceramic production.

Italian Porcelain and Earthenware Production

You find the bulk of industrialised ceramic production in Italy dispersed

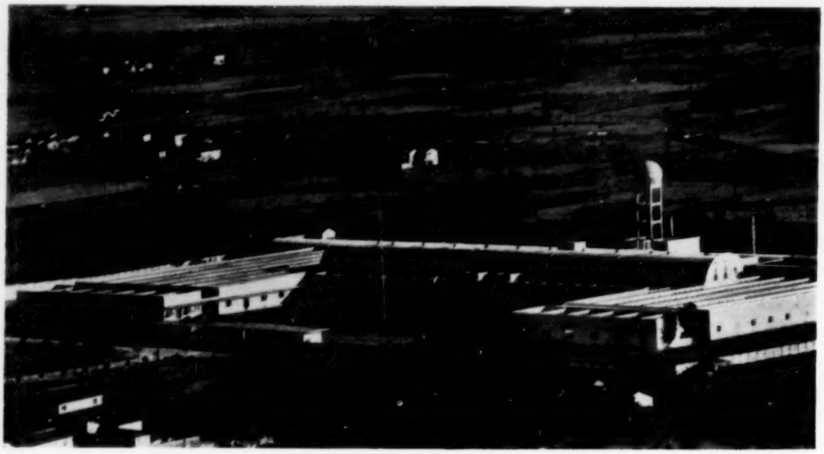


Fig. 1

all over the country, north of Rome.

In this way, Italian whiteware production differs essentially from industrial concentration in one locality as in Stoke-on-Trent, in England.

In Italy as in Western Europe, concentration of the industry in one locality is the exception, rather than the rule as in England. It may be that concentration has many advantages, especially with regard to the availability of supply of operatives and craftsmen; but geographical dispersion can lead to less parochialism as regards factory design, types of machines and methods, firing techniques, decoration systems and methods, and constructive thought in general.

In Italy, we, therefore, had the opportunity of seeing, during the course of a limited number of factory visits, a considerable variety of machines, tunnel ovens and kilns, general systems and even many different types of body recipes in action. What had been considered best for the job in hand has been selected, obviously after considerable planning, forethought and experiment, from the best that British, German, Swiss, French, American, Czechoslovakian, and Italian inventive genius, technique and sources of raw materials could offer.

As a consequence, much could be seen and learned during visits of relatively short duration.

Factory Planning, Design and Layout

Look at Fig. 1, and you will get some idea of the type of factory seen during visits to the largest works, at Lavem (Societa Ceramica Italiana), and in the districts of Milan, Florence and Pisa (Societa Richard-Ginori). The exterior, typical of modern factory design at its best, provides a good clue as to what the interior is like. The single storey principle of factory construction is typical and common throughout the whiteware industries and is conducive to simplicity, utility and efficiency. The photograph is an aerial view of the felspathic porcelain factory of the Richard-Ginori group at Sesto Firentino, near Florence.

This, and similar factories visited, can employ upwards of 700 operatives.

Look now at Fig. 2. These views are selected from photographic records of the state of some Italian pottery factories following bombardments during 1943 and 1944. The reconstruction from such chaos, of factories in the most modern styles provides a clue to the present-day status of Italian post-war ceramics in general. In fact, factories untouched by war, are on a par with those which have been completely reconstructed. Very old established plants, like that at Laveno, founded in 1740 evince similar evolutionary planning, internally and externally.

In all factories visited, whether

Fig. 2. Italian pottery factories after Allied bombardments in 1943 and 1944

large and new, small and new, or old and small, it was obvious that all forms of mechanisation which favour production efficiency — conveyor systems, milling and making plant, continuous drying and firing methods based on the concept of simplicity with rapidity — have been wisely, cleverly and successfully adopted.

As a consequence, many of these works will bear comparison with the best ceramic plants in the world. Many ceramic roads can still "lead to Rome."

Mechanisation of the Whiteware Factories

Making Machines. Perhaps because many different types of earthenware bodies were being produced, greatly different types of making machines were seen in action. Thus, in one large factory, a complete absence of semi-automatic jiggers would be noted; while in others, even under the same administrative control semi-automatic jiggers made in Stoke-on-Trent were prominent. In yet another works, hand jiggers were in use for certain shapes, together with the American Miller fully automatic flat making unit for a 24-hour day output of plates and saucers. Drying units were correspondingly versatile in construction and principle. It was not noted that any high-velocity hot-air directed jet driers had yet been installed.

Mechanical bat-spreading, almost universal practice in British factories, was not seen. In its place, general practice in Italy has followed the pattern, which is prominent in certain French, Belgian, Dutch and some German units, of wire-cutting slices from columns of vertically extruded de-aired clay. The slicing operation is semi- or fully-automatic and produces up to three dozen slices in as many seconds. These slices are deftly placed, rather than vigorously thrown, on to the moulds.

Conveyor Systems. The largest factories evinced a persistent determination to prevent anything becoming stationary along the production lines. Conveying started at the raw material storage and extended through the mill and slip house, to the making shops, biscuit firing, glaze dipping, glost firing, decoration shops, and finally to and from the packing house.

In the slip house, crushed or granulated clays were being conveyed to the blungers in asbestos buckets of convenient bulk capacity, hanging on pendulum conveyors, using a special overhead propulsion system, as illustrated in Fig. 3.

Fig. 3

After making, the goods were continuously on the move, passing through the drying systems to the biscuit placing site. Three dimensional movement of the conveyor systems inevitably brought the goods to hand as required, and then passed them forward to the next sequence. The primary function of any conveyor system—to reduce labour and its cost in transfer and transport, to a minimum—had been effectively combined with the additional objectives of eliminating the diversion of productive labour to non-productive tasks, and to making one conveyor line perform several labour saving economies simultaneously.

Thus, the conveyor in a drying system was being used to carry dry moulds to the clay maker, remove his output as soon as made and to carry, on different shelves, empty moulds, ware on moulds and ware off moulds through one drying unit and past the biscuit placers. In fact, there was much to support the idea that the conveyor system of a newly planned factory had been the first item on the drawing-board; and the factory, the kilns, the operatives and their machines designed or positioned accordingly.

Driers and kilns were part of the continuous forward movement from the clay-bins to the despatch lorries.

Glaze Application. In the larger factories, not much hand-dipping as we understand it was seen. Many shapes, when hand dipped, were held in special sprung tripod grips. Very porous ware was being dipped in slop glaze at exceptionally low slop weight. Neither artificial dry glaze hardening, nor chemical glaze conditioning were in evidence.

The alternatives to hand-dipping were aerographing by hand or by mechanically operated guns. There were Schweitzer rotary spray machines operating on high outputs, with the inevitable conveyor dealing with the problems of feeding and taking-off. Quite naturally, it seemed, the conveyor delivered the dipped and dried goods to the glost placing stations.

Decoration. Decoration methods exemplified two extremes. In the major case, much individualistic decoration was by hand by true artists, or more abundantly, by the more formal bulk production craftsman-artist, and in the other extreme, by hand operated or fully mechanised silk-screening, on-glaze or under-glaze.

Full use was being made of aerography for the application of colour—monotone or multi-coloured pattern, under-glaze and on-glaze.

In the smaller artware hand-craft factories, very small guns with almost pin-point sprays, were being used with excellent effect, similar to brush pencilling.

Some gold lining machines—made in Longton, Stoke-on-Trent—were seen in action, performing more than one operation. Ceramic colours made in Britain or obtained from Continental or Italian sources were being freely intermingled.

Firing Techniques.—Biscuit and Glost. In some of the older or smaller factories, firing by wood was prevalent, but even this was made fully automatic as regards feed and control.

The wood was of a hard granulated variety, the feed mechanical (similar to some coal-fired underfeed installations in use in Britain), and the control, both of feed and temperature, automatic.

In the new and largest factories, tunnel firing is almost universal. The main fuel is electricity, except in certain geographically favoured localities where natural gas is available. Open placed or sagger-placed biscuit firing was in use, sometimes both in the same kiln; also in the glost tunnels.

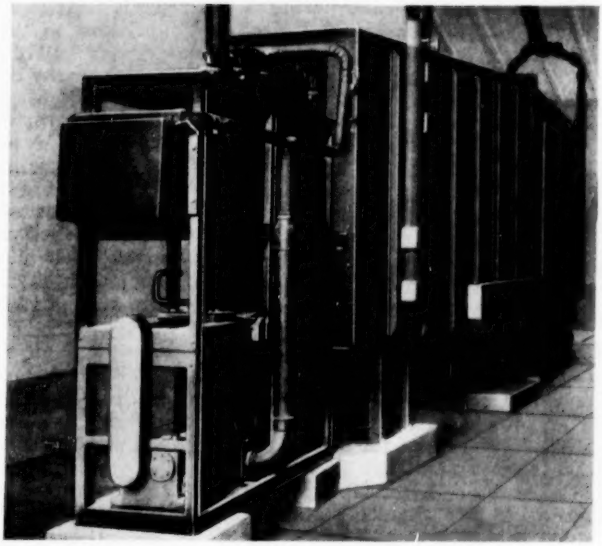
Saggar used in glost placing were often frames rather than boxes, to facilitate rapid heating and simple placing. Propulsion of the goods through the tunnels on bats, rather than on wheeled cars, was prominent.

Decoration Firing. Strange though it may appear, the modern method of firing on glaze decoration and gold in Italy seems to be pointing to the future system of biscuit, glost and decorating firing.

Small units electrically fired, and under 40 ft. in length, were seen in use for the firing of decorated goods.

Generally, the construction is simple, with transverse heating elements extending from one side to the other, usually with two passages one above the other, travelling in opposite

Fig. 4



directions. Output from such units can be very high, considering the smallness of the kiln, and power consumption low because of the use of transverse heating elements, and movement in the opposite directions, giving a high heating transfer factor. Good insulation ensures low heat losses by conduction and radiation from the exterior of the kiln.

In one artware factory, a small tunnel of this description was firing the entire production of the plant in a triple deck tunnel, biscuit, glost, and enamel. Each passage and the complete unit was controlled automatically. Biscuit and glost passages carried their respective loads on refractory bats, which were pushed. The decorating passage, with temperatures below 800° C. was being propelled by traction, using interlinked bats made of unoxidisable metal. These units are produced by the Italian furnace construction firm of S.I.T.I. of Novara. (Fig. 4.)

Other tunnel kilns of Belgian, Swiss, British and German origin were in prominent use for bulk production of biscuit and glost, but the S.I.T.I. principle was particularly evident in the smaller factories, old and new.

Technical Business of the Congress

The lecture programme was sectionalised as between (a) Scientific: (b) Heavy clays; (c) Refractories; and (d) Whiteware.

The scientific and whiteware section lectures were mainly of interest to the whiteware groups.

The standard of all papers was high, but reference can only be made here to a selected few. The paper on Crystal Chemistry and Ceramics by Prof. Y. Letort of France, attracted a large audience, and contained references to the values of zirconia and titania in giving acid and alkali resistance to enamels and colours.

The paper by Mr. S. A. E. Berg of Denmark provided interesting and useful data on the determination of grain size particle distribution, of quite large sized particles by the combination of sedimentation technique in a viscous medium such as ethylene glycol.

The important relationship between elastic-plastic deformation characteristics of a ceramic body, and its resistance to the effects of thermal shock was detailed by Messrs. H. Detaille and J. Wins of Belgium.

Other important contributions were made by ceramic scientists from Austria, Norway, France, the Saar, Germany and Italy.

The whiteware lectures included fundamental studies presented by Dr. H. Salmany of Holland on the "Surface tension effects and the structure

of the clay surface," and by Mr. S. T. Lundin of Sweden on "Electron Microscopy of Whiteware Bodies." Contributions from Britain were covered by K. W. Cowling and Dr. J. White with "Vermiculite," and by Dr. N. O. Clark on the "Properties of China Clay."

The Social Side

As was to be expected, the social amenities of the Congress were excellently catered for by our Italian hosts, and nothing but unstinted praise must be extended to Congress secretariat and to the individual organising committees. From the first luncheon on 27th September on the quaint island, "Isola dei Pescatori," in Lake Maggiore to the final function, the reception and ball in the famous Sala Bianca of the Pitti Palace in Florence, the same high standard of true hospitality was in full evidence.

The "Chamber of Commerce" luncheon in the Odeon restaurant in Milan on 28th September, and the luncheons in the Medici Villas near Florence will always be remembered for the beauty of the villas themselves and the high quality of the repasts. The ball game of "Calcio," played in the beautiful setting of the Boboli Gardens, adjoining the Palazza Pitti in Florence, thrilled, excited and amused those who were privileged to watch. Played in costume, the game proved to be a strange cross between English rugger and American soccer, with no holds barred.

The richness of the architecture, mural designs, tapestries, and furnishings of the Sala Bianca cannot adequately be described here. The memory of these beautiful settings will always remain with us.

To all individuals who gave their services to the many organising committees associated with this Fourth International Ceramic Congress, we offer our grateful thanks and unstinted appreciation.

Practical Hints on Slip-Making

by

KENNETH ROBINSON

THE actual method of mixing I want to talk about is the dip stick method. Mr. Johnson of Service Engineers not so very long ago gave a paper to the Association in which he included the weight volume method and dealt with it in far greater detail that I can hope to do at this stage. In any case the dip stick method is still used to very great advantage within the industry by many manufacturers. Just how accurate and efficient the weight volume mixing is I don't quite know, because not being conversant with that method I only know of the very high reputation in which it is held in many quarters, particularly America. But with the dip stick its greatest advantage is that it becomes more efficient and accurate as the size or volume of the mixing increases because the less the percentage error becomes all the time.

The less that this error is, and it is impossible to rid oneself of it entirely, then surely that is something that is going to be appreciated in the making shop. I say this with at least one eye on the method of making, particularly auto and semi-auto methods, where in the production of articles the machine will repeat to a pre-determined setting the same making cycle consistently. Before these machines were introduced into the industry with the purpose that they have been for a number of years past, clay standardisation in and from the sliphouse was nothing like so important as it is today. If a clay used for hand making was found to be deficient in its making quality then it was possible for the maker to adjust or adapt himself accordingly, but it is impossible to expect a machine to do likewise.

A paper presented to the Stoke and Hanley Branch of the British Pottery Managers' and Officials' Association, on 16th October, 1954.

Therefore, I would emphasise just how important sliphouse standardisation is if these machines are to be the efficient asset to production that they can be.

Unfortunately, a little tolerance in clay quality must be accepted because the body itself is made up from naturally occurring clays and it would take something more than a specialist's knowledge to forecast their performance throughout all the processes of manufacture, but even so this tolerance must be reduced to an absolute minimum and maintained.

The first place to start is with work of a technical nature on the individual clays and milled materials themselves and to arrive at their set standard of performance, but as I don't want to make this paper of a technical nature I am going to pass over the dozen or so important tests that are involved.

Ball Clays:—Stock to weather in the open, the longer the better, as this breaks down the clay more readily, on the yard and in the blunger. Use deliveries of ball clay in rotation, that is to say, ball clay delivered at the beginning of the month to be used at the end of the month, consequently a little organisation is required with the deliveries from the mine to the works, particularly if accommodation in the clay yard is restricted, as is often the case. Just a little bit of thought and foresight, and not much other effort, is all that is required, and it is time well spent also in keeping the clay yard tidy.

China Clays:—Require very little if any attention at all to stock as owing to their nature weathering will not improve their performance. Because of their quality they are, or at any rate should be, stored under cover, and very often this accommodation is something that resembles a broken-down shack.

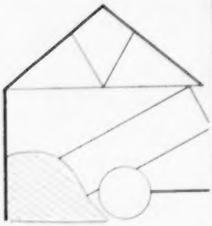


Fig. 1

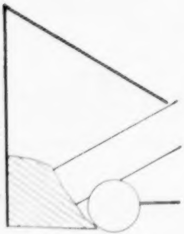


Fig. 2.

Because of this neglect, decayed brickwork or tiles for that matter, could fall into the clay, and then it is most important that the inconvenient trouble of hand picking be carried out, otherwise, should the debris pass unnoticed and be charged into the blunger, it would not be long before it stalled, often with serious consequence.

Another point worth considering in stocking china clay under cover is the type of roofing above it. Very often it is some sort of prefabrication, asbestos sheeting being far better than corrugated metal sheets, insomuch that unless they are proofed against rust, nothing short of iron specking is encouraged.

With metal roofing that is not proofed, it is possible that an irresponsible haulier, when delivering, will raise his tipper too high with the result that the roof is knocked and a certain accumulation of rust is disturbed showering into the delivery.

Added to this discomfort is the fact that without the attention that unproofed sheet metal roofs require, time and weather will corrode holes in the roof. The first heavy downpour thereafter will wash all the rubbish, that one is so anxious to keep away, through such holes and on to the china clay.

Today many firms work to a system of china clay dispatched from the mine by rail in trucks to the nearest convenient railway siding for collection by road transport for delivery to the works. Because of this the design or type of clay shed is most important from an economical point of view, or for that matter for convenience. The fact of the matter being that to facilitate delivery right into the shed it should be sufficiently high enough at the front to allow the lorry to lift its tip to a maximum without lifting the roof off.

The idea being that with such height available, deliveries are tipped into a tall, neat and compact pile. Some sheds resemble something like Fig. 1 or Fig. 2 with the front here, and with the height being so restricted that the tipper cannot be used to its best advantage.

Deliveries have to be shovelled off and into stock or else the lorry, with its tipper part-way up, its backboard off, will drag clay out of the shed. There is a type of shed which I put to you as being comparatively ideal for china clay stock, in which the required height is at the front, but unless something is done about the wide open space at the front, this also leaves a lot to be desired.

Therefore, imagine something like a horizontal gate or shutter hinged to the uppermost beam and suspended to a height to leave clear headroom for anyone working in the shed to get in and out of it (Fig. 3). The general idea is that when deliveries are made the gate or shutter is, by means of pulleys and a little effort on two ropes, to be lifted upwards and inwards so that the lorry can get right into the shed and there to be able to raise its tipper to the maximum, so tipping the load into a neat pile (Fig. 4).

In so far as practical sliphouse work is concerned we should deal first of all with the blunger charger whose chosen lot in life is to wheel up the clay from the stock deposits and to charge it into the respective blungers. Different factories that manufacture their own

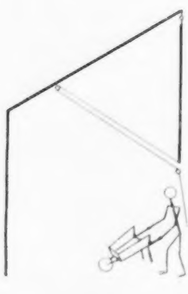


Fig. 3

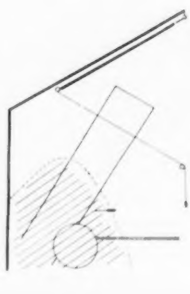


Fig. 4

body always seem to have different recipes from the next, in fact there are no two factories with an individual identical body, but it is standard practise in the industry to use either two or three ball clays and one or two china clays. Once a recipe has been decided upon something of a serious attempt must be made to maintain these ratios, particularly if there are only two blungers available, that is to say, a ball clay and a china clay blunger, and a not too rough scale can find a useful purpose on the clay yard.

I put it to you that several small blungers, each responsible for an individual clay, could give a far greater degree of recipe and accuracy than two larger ones, for the ball and china clays.

If conditions are such that there are only a ball and china clay blunger available then their capacity alone should govern the size of the mixing, if it does not and it is dependable upon the ark then it isn't a bad idea to get a bigger "hole" for mixing in. It seems rather pointless to me, and bad economics anyway, to have a blunger which will blunge, say, 300 galls. quite efficiently when only 200 galls. are required to satisfy the recipe.

Consequently, if this is the case it may be found that, for the sake of engineering either a deeper or wider mixing ark, blunging time and its efficiency would be improved, or production increased accordingly.

For that matter you might check your mixing ark and blunger as they are at present to see that the ark in particular is being used to its full capacity; who knows, you might even squeeze another 6 in. onto your mix after all without any excavations at all.

Blunger charging itself is something far more than simply throwing clay into water and stirring it until the lumps are down into fines, and then running off.

A quarter of an hour or so spent in breaking down the clay lumps before charging will reduce the blunging time considerably insomuch as a greater area of clay surface is exposed to water in the blunger.

It is considered advisable to blunge clays at approximately $\frac{1}{4}$-$\frac{1}{2}$ ozs. about the running of pint weight because it is far safer to add water to clay to reduce the pint weight, than to add clay to increase it, some clays breaking down easier than others. If, however, the pint weight is found to be slightly on the light side, then it does not necessarily mean that the end of the world has come, or that the next mixing must be delayed while the pint weight is corrected. One does not have to be a mathematician to correct the dip stick accordingly and with absolute safety in extreme circumstances, although it is not an advisable practise, but if it is something of a regular occurrence, then one must bear this in mind in the design of the dip stick and adapt it to accommodate such alterations.

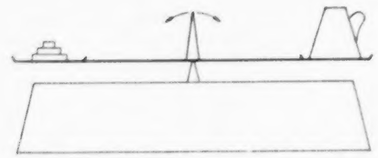
There is one very important point that comes to mind with regard to the blunging of clay, and that is when the element of the weather interferes, if the clays become frozen as they quite often do, and they are charged to the blunger like this, then so much of the blunging time is spent in defrosting that a representative mixing from the blunger, whether ball or china, is virtually impossible.

The use of warm water for blunging in these circumstances serves a far more thorough and uniform purpose than unsightly fire buckets strewn over clay stocks, not particularly because they are unsightly but because they don't serve any purpose except to burn coal and to defrost about a shovelful of clay on which they stand.

There is, however, a point worth noting in using warm water and that is that it must not be so hot as to vapourize steam, or when the time comes to run off you are all fogged up in the mixing, and then you cannot see what goes on way down there.

Flint and stone should be products of specialists; manufacturers that mill their own obviously do so with satisfaction; others that don't or can't for various reasons, would be well advised to deal with millers of the highest reputation who should know your exact requirements. Even then these people fail occasionally, and if ever materials are delivered either at very high or low pint weights against average, then be suspicious immedi-diately, or better still send it back to where it came from because if this does happen then something has gone wrong with the mill.

If you take the trouble to make one or two enquiries, more often than not



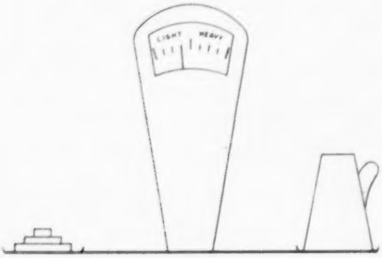


Fig. 5. (Top) Scales without a dial such as these are never satisfactory.

(Bottom) Satisfactory scales which give a positive indication

the stock agitator has been out of service for some time, and this is a very important point with mill materials. Once they have set it takes a tremendous effort to obtain uniform suspension again, particularly with stone which is very difficult to get up once it has been allowed to set. If you are offered milled materials at an unusually high weight then it's even money you have got an early run off from a stationary ark, and if it is unusually light then you could be somewhere near to the top and the last with an excess of fines.

In any case whatever has happened no one would be well advised to use milled materials at fluctuating pint weights. If the agitation is satisfactory and the pint weight constant, then the grinding weight is wrong, and there are certain definite pint weights for satisfactory milling of any material.

Having made something of a serious attempt to tie up loose ends with the raw material, paramount attention must be given to the recipe, by that I mean to stress the importance of weighing out. First of all it must be in the hands of a thoroughly competent and conscientious person who understands and appreciates errors that can occur and exactly what influence they will have on production.

Now there are scales, and scales. Those used in all sliphouse work should be the best that money can buy for the job, deadly accurate with the pointer right on the dot at zero. Maintenance at frequent intervals by a scales mechanic is done far too infrequently for sliphouse work. Beam scales with a pointer that wobbles about centre to fall either to left or right denoting either heavy or light, are definitely out.

Something with a dial to work to is far more accurate where the pointer creeps along a scale showing exactly how light, heavy or spot-on is the weighing (see Fig. 5).

Like scales there are also pint pots, the narrower the filling area then the less is going to be the weighing out error (Fig. 6), inasmuch that all slip processes surface tension, and if the can does not balance to its counter weight exactly then you want one that does.

The definition and appearance of a potter pint can, is a conical container which, when filled with tap water, weighs exactly twenty ounces to the dot. If it is battered and dented and still weighs twenty ounces I suppose that it is still a pint can, but comes the time when it get dented again and that one passes unnoticed; not a very good practice and one that will encourage errors.

The pint can is the most important thing in the sliphouse, or factory for that matter, because you stand or fall by it. When not in use it wants to be more or less wrapped in cotton wool. When in use, use it with the care that you would articles of our finer produce or even greater.

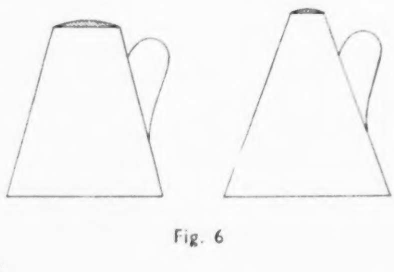


Fig. 6

Always bear in mind when weighing a slip that it is from the bottom of the container that you run off, not the top; so remember this at the time.

A final word on weighing, and that is to check the weights themselves every time they are used. Very often a two-ounce weight weighs two ounces plus a bit of clay that has got stuck into the crown stamp recess.

There is not much that can be said really about the actual running off into a mixing ark except what is common sense. Check the flags on the dip stick noting their corrections, particularly the flint and stone, and make sure that it rests perpendicularly in a fixed tight position.

Talking about the dip stick, it is not a bad idea to have it fitted with a metal toe to serve a two-fold purpose. If it is made of a soft material, like wood, for instance, constant dropping into the ark will in time wear away the initial wet inches, usually the ball clay.

If a dip stick is made of wood, and I don't see any reason why it should not be, except that it could warp, then a metal toe, if heavy enough, will prevent it from floating.

The mixing ark should be well lit so that it doesn't cast shadows, and the lighting medium, if an electric bulb, should be shielded from slip splashing so that the ark is not bust into total darkness.

Don't try to rush the mixing or running off, and see what records can be broken. It is the most important process in the industry. Above all don't ever allow the feed to get out of control and cover the markers. In fact as the level approaches the marker its feed should be slowed down to barely a trickle.

There is in my opinion a certain point or place to stand while calling out the mixing, that is to say, where one can see to the best advantage the progressive rise of the level of the slip in the ark.

That point is not vertically or immediately above the stick because the first indication of the level is when the marker disappears from view and then the mixing is overshot.

Use a deeper marker or pointed flag. preferably pointed and painted in a distinct colour. During running off place oneself in the best possible vantage point to witness the level of the slip coming up the side of this flag to the mark.

The pint weight of the body mix should be that at which it will pass the magnet sifter unit, without choking either. If you go any lower to be on the safe side, then you are kidding yourself into stocking water and not clay slip.

If the unit chokes about 27-26½ ozs. per pint, then it is the unit that requires attention and not the pint weight adjusting.

Once the body has been mixed the slip must be kept on the move all the time until it is dewatered in the filter cloths, quickly at first, before it is pumped from the mixing ark, where every effort must be made to offer a uniform or consistent slip into stock for pressing.

There is quite a lot that can be done with scraps, the success of which depends chiefly upon the facilities available and the technical knowledge of the sliphouse controller.

Then again, his work is limited to the amount and type of scraps of clay that are incurred during making.

If he knows exactly what he is doing, and he shouldn't hold such a responsible position if he doesn't, then the problem of clay scraps is not quite so serious as it appears.

This point of view becomes a little more obvious to manufacturers producing with semi-auto's. If the roughing tool is set correctly then it should collect most of the scrap clay, and as the roughing tool is not water sprayed, it is correct to say that this clay scrap so collected is off a neat wad. Under normal practice it is the same clay that would be used for making casting slip, that is to say, either from a wad or press cake.

By collecting it separately from slurried scraps, casting slip can be made from it quite safely, either in entirety or by introducing certain percentages, depending upon the amount of the correct type of scrap clay available and the casting slip demand.

By using this clay for casting slip, economy is effected. This scrap clay needs no further processing, that is to say re-slipping and pressing, before it can be charged to the casting slip blunger.

I would not advise anyone to use

slurried scrap in casting slip, the scraps from a making tool or a jigger box, because no matter how hard they try they will struggle every time with a trial and error method for something of a correct pint weight.

No more would I advise anyone to use casting scraps in casting slip, unless in extreme circumstances where the casting is too slow and the quickening is not improved by soda ash additions.

It may surprise some people to learn that properly treated casting scrap can be used quite successfully for plastic making, although these people should be few and far between, because I understand that the neutralisation of casting scrap with acid is widely used now.

Actually, better results are obtained in practice if one goes slightly beyond the point of neutralisation to acidify, but not too far otherwise certain type of press cloths will disintegrate. Just how true it is that acidified clay precipitates certain kinds of gelatinous silicates I would not know, but it will certainly improve the green strength and possibly the plasticity of the clay.

Possessing these two very desirable qualities, clay so treated will find considerable favour in the holloware, dish-making and big flat shops. Anybody who is neutralising casting scrap or thinking of neutralising casting scrap for plastic making must make a very serious attempt to keep its scraps with the casting scraps and not with the plastic scrap.

As illustrated in production, scraps from the holloware and dishmaking shops should be returned to the casting scrap pen and not the plastic making scrap pen.

If acidified scraps or clay get back into the casting slip then because of this neglect you are landed with quite a problem determining the alkali correction.

These schemes, like far too many well thought out schemes concerning the industry in general, have their very severe limitations, and their introduction and success, as always, depends upon the facilities available.

As I said at the beginning no two factories in the industry are exactly alike and therefore it seems rather pointless to give you a set plan for these two scrap schemes except to say that you will require two small arks, one of which could be used for mixing and the other must be geared to the magnet sifter unit and to the pumps.

There is, however, a set plan for determining exactly to the pound the exact quantity of scrap clay which is reprocessed. This to my mind is a very useful piece of information, involving only a uniform container into which slipped scraps are run, the pint weight of each individual scrap charge and a dip stick.

The dip stick should be inserted into the scrap container and the wet inches read off on a calculator against the respective pint weight.

Acknowledgments

In concluding I would wish to thank the Asociation for their invitation to read this paper. To Mr. G. Evans and Ashworth Bros., for their permission to read it. To Mr. G. Vardy, my very capable assistant, who is very closely associated with me in this work—and to Mr. Glover, who has given me considerable help with the preparation of this paper and the pitfalls that I am now going to fall into!

Ceramics and Smoke Abatement

Points from the Recent Conference

AT the annual conference of the National Smoke Abatement Society which was held in Scarborough recently, Mr. R. F. Hayman, who is Industrial Gas Officer for the Gas Council, and Mr. J. I. Bernard, the Chief Technical Officer of the British Electrical Development Association, spoke on the developments in the industrial uses of gas and electricity respectively.

Gas

Mr. Hayman who gave ceramics the place of honour in his list of basic industries said that it is perhaps in the fields of ceramics and the production of pottery that industrial gas and smoke abatement can be considered to go hand in hand in the most striking way.

Town gas in this industry is being used extensively, not only for firing clay ware, but, for example, drying, bone calcination and frit melting. The progress of gas-fired equipment in the Potteries has been phenomenal and the field is now being extended to the firing of floor and roofing tiles and other heavy clay products.

The growth can be illustrated by the fact that before the war it has been estimated that one million tons of coal were used in the Pottery Industry only in Stoke-on-Trent. The change-over from coal to gas firing has helped to reduce this figure to 400,000 tons. In 1952, for instance, some 23 million therms of gas were used for pottery firing, to produce which the gas works required approximately 280,000 tons of coal. It is estimated that this quantity of gas replaced 336,000 tons of coal previously used in the raw state.

There are three main problems in the production of ceramics:

1. The firing of clay ware in the basic state at about 1,100° to 1,200° C.
2. The firing of glost ware at about 1,000° to 1,100° C.
3. The firing of decorated ware.

In all these cases, there is a wide range of gas heated plant and for large scale production the continuous kiln is rapidly assuming the most important role.

Progress in firing by gas of continuous tunnel kilns is shown by the following table from German[1] giving installations in Stoke-on-Trent:

Year	*Consumption (cu. ft. by 10^3)*	*No. of kilns*
1932	7,443	1
1934	88,519	9
1937	617,148	48
1939	1,341,337	74
1945	1,223,450	84
1951	4,228,980	204
1952	4,760,570	229

The many advantages of continuous tunnel kilns have been summarised by Davis[2] as follows: economies in fuel consumption, production of better ware, improved control of firing processes, reduced labour costs, better working conditions, reduced expenditure on saggers, continuous output of gas.

In the continuous kiln, control of temperature across a section, and indeed of the whole firing cycle, is easy. Handling is reduced to the minimum and one particularly important point, the loss of heat, and wear and tear on the oven structure common in intermittent heating and cooling is very substantially reduced.

Mr. Hayman showed an illustration of one of the latest examples of a continuous kiln firing once-fired sanitary fireclay ware. This kiln is 416 ft. long and has an approximate gas consumption of 47 therms per hour. It is a muffle kiln in which the system of combustion is a gas-air 1 to 1 premix by volume. This mixture is discharged at 3 p.s.i. through injectors which induce the remaining air required for combustion directly from the tunnel. Combustion takes place in a closed chamber set on either side of the tunnel. This arrangement gives preheated secondary air at a high temperature, about 900° to 1,000° C., ensuring economy in gas consumption.

The development of a good kiln is dependent, among other things, on suitable refractories and continuous improvements are being made. Economies can still be made by paying close attention to burner and combustion chamber design and the use of pre-heated air for combustion. A growing use is also being made of light weight insulating refractories, which have a low heat capacity and, therefore, enable a kiln to heat up quickly, but which are tough enough to enable quite strong structures to be built.

Their low thermal conductivity and small pore size minimise heat losses. These advances are similar to those continuously being carried out in all branches of furnace design.

A valuable record of the work now being carried out particularly on the newer high temperature refractories is given by Dodd.[3]

One point, if not peculiar to the pottery industry, certainly of great significance, is the need to use saggers and large masses of car and kiln furniture to support the ware. Growing attention is being paid to the use of light-weight kiln furniture and where possible the use of open or direct fired kilns in place of muffle kilns. Such a design eliminates the need for expensive muffles and materially raises the thermal efficiency of the structure.

The smaller section of the industry which concerns itself with educational, studio, or art pottery is an important one, which is spread more or less evenly over the country. The problems in this field are often economic in that kilns are required for the minimum price. On the other hand, even a small kiln is a piece of equipment carefully designed for its job and it should not be turned out by the amateur. To meet the need for the student or craftsman who wishes to indulge in the production of ceramic work, a variety of equipment operating at temperatures up to 1,450° C. can be produced. The lower temperature range up to 1,200° C. is of particular value to schools and educational establishments where increasing interest in the subject is being taken.

Electricity

Mr. Bernard spoke of the part played in ceramic industries by resistance furnaces. Special types of elements have to be used to provide higher temperatures than are required, for example, in the vitreous enamelling processes. Mr. Bernard explained how the electric kilns were usually in the form of a tunnel through which the ware passes slowly. "There are often twin tracks with the ware moving in opposite directions so that the incoming charge is heated by the outgoing ware, thus improving the thermal efficiency. The important part in regard to productivity is that the quality of the final product is higher owing to the accuracy of control and the absence of sulphur, dirt and high temperatures. In addition the amount of labour required for supervision and repairs is very low. The number of electric kilns in use in the Potteries is now in the region of 150 and it is estimated that they have obviated the burning of over 100,000 tons of coal in the old fashioned bottle kilns."

References

1. W. L. German, *Ceramics*, **5**, 400, 1953.
2. K. Davis, *Ceramics*, **5**, 24, 1953.
3. A. E. Dodd, *J. Inst. Fuel*, **26**, 312, 1953.

New Quickfit & Quartz Agents.—Quickfit & Quartz Ltd., manufacturers of interchangeable laboratory and scientific glassware of Stone, Staffs, have appointed selling agents in Dublin and in Wells, Somerset.

The Dublin agent is Thomas H. Mason, of 5-6 Dame Street, Dublin, and the agents in Wells are Sutherland and Thomson.

They have also appointed the Wakefield Company of Shebrooke Street West, Montreal 2, as their agents in Montreal and Ottawa.

I.G.M.'s First Annual Dinner.—His Grace The Duke of Rutland and the Rt. Hon. The Lord Balfour of Inchrye, P.C., M.C., will be among the guests of honour at the first Annual Dinner of The Institute of General Managers, to be held at The Savoy Hotel, London, on Friday, 3rd December, 1954.

Their presence is particularly appropriate as The Institute is essentially a Commonwealth association of managing directors and general managers. The Duke of Rutland is president of The College of Industrial Management and Engineering and director of a number of Companies. Lord Balfour, well-known as a statesman and man of business, has done much to foster industry and commerce in the British Commonwealth and Empire. He is chairman of the Empire Industries Association and past president of The Federation of Chambers of Commerce of the British Empire.

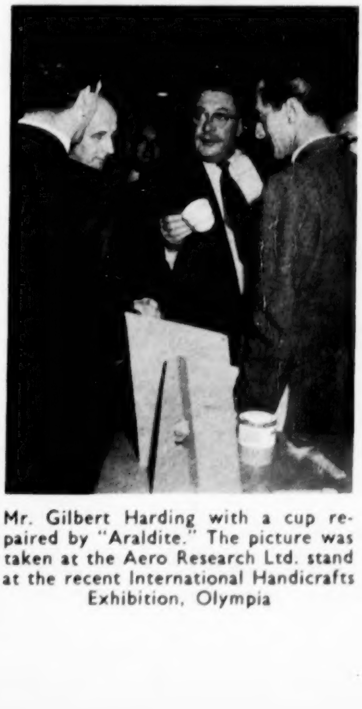
Chief executives wishing to attend the dinner, or to receive further information concerning the aims and objects of The Institute should write to the Registrar, The Institute of General Managers, 86 Eccleston Square, London, S.W.1.

J. Kenneth.—The death has occurred of Mr. James Kenneth, of Lochgilphead, who was for many years connected with the firm of **A. Kenneth and Sons Ltd.**, brick manufacturers, of Ayrshire, which, until nationalisation, owned large coal mines in the county. Mr. Kenneth, who was seventy-five, was a Justice of the Peace for Argyll. He is survived by his wife and family.

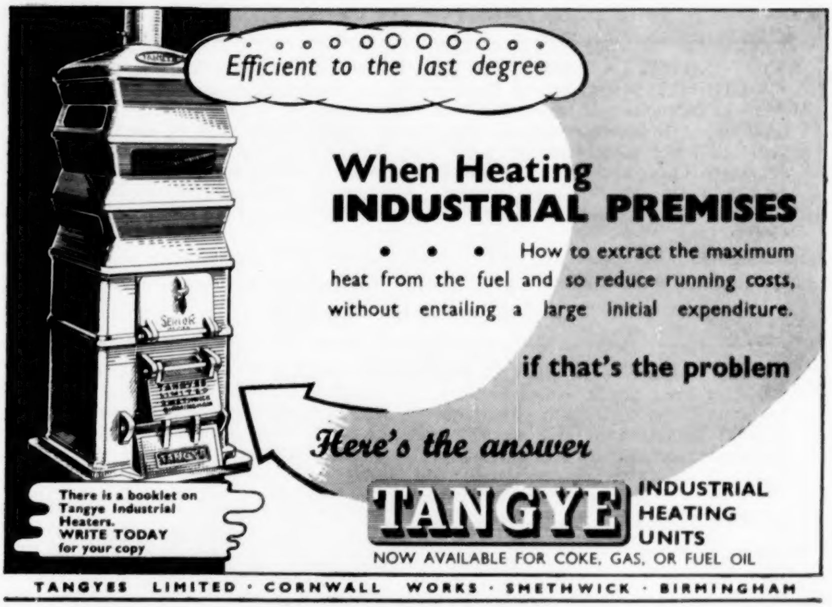
D. R. A. Pistor.—We record with regret the death on 23rd September while on holiday in Scotland of Mr. D. R. A. Pistor, for nearly forty years manager of the Hibbert Street Works of George Kent Ltd. Mr. Pistor was a director of B.K.B. Electric Motors Ltd.

J. B. Charters.—Mr. J. B. Charters has succeeded Mr. Marsden Ryle, who recently retired, as manager of the Osram Glass Works at Wembley and Lemington. Mr. Charters began his career with The General Electric Co. Ltd. at the Osram Lamp Works, Hammersmith, and was assistant factory superintendent there when he joined Wembley Glass Works in November, 1943 as factory superintendent. Later, in January, 1947, he was appointed production manager.

The post of production manager left vacant by Mr. Charters has been filled by **Dr. F. S. Hawkins**, who before joining the staff of Wembley Glass Works in February this year, was in charge of the Glass Department at the Research Laboratories of the company.



Mr. Gilbert Harding with a cup repaired by "Araldite." The picture was taken at the Aero Research Ltd. stand at the recent International Handicrafts Exhibition, Olympia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Aerograph Co. Ltd., The ... 386
Amalgams Co. Ltd., The ... October
Associated Lead Manufacturers Ltd. ... 428
Berk, F. W. and Co. Ltd. ... October
Blending Machine Co. Ltd. ... 390
Borax Consolidated Ltd. ... October
Boulton, William Ltd. ... 405
British Ceramic Service Co. Ltd. ... 392
British Electrical Development Association ... 389
Christopherson, Clifford and Co. Ltd. October
Cyclo Gear Co. Ltd. ... 424
Davies, James (Burslem) Ltd. ... 431
Dohm Ltd. ... 399
Electrical Rewinds (Burslem) Ltd. ... 426
English Clays, Lovering, Pochin and Co. Ltd. ... October
Gas Council, The ... 394
Gibbons Bros. Ltd. ... *Cover ii*
Greening, N. and Sons Ltd. ... September
Grose and Stocker Ltd. ... 429
Honeywell-Brown Ltd. ... 385
Kent, James Ltd. ... October
Lafarge Aluminous Cement Co. Ltd. ... 387
Malkin, F. and Co. Ltd. ... 429
Manesty Machines Ltd. ... June
Modern Mechanisation Ltd. ... May
Morgan Crucible Co. Ltd. ... *Cover iii*
Nu-Swift Ltd. ... 427
Pitman, Isaac Ltd. ... June
Potclays Ltd. ... May
Potteries Ventilating and Heating Co. Ltd. October
Protolite Ltd. ... 430
Rapid Magnetic Machines Ltd. ... 418
Rawdon Ltd. ... *Cover i*
Sismey and Linforth Ltd. ... 388
Sprechsaal ... 412
Sugg, Wm. and Co. Ltd. ... 430
Tangyes Ltd. ... 431
Thermic Equipment and Engineering Co. Ltd. ... September
Universal Furnaces Ltd. ... May
Victoria Heating and Ventilating Co. Ltd. October
Wadsworth, Wm. and Sons Ltd. ... 428
Wengers Ltd. ... 427
Wilkinson Rubber Linatex Ltd. ... 391

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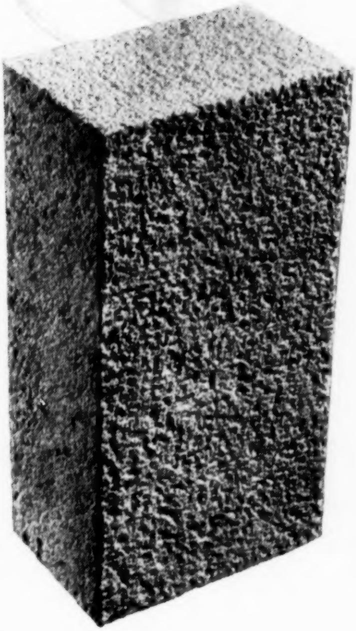

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